UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/710,278	06/30/2004	Daniel J. Weyers	148115	4277

23413 7590 12/12/2005

CANTOR COLBURN, LLP
55 GRIFFIN ROAD SOUTH
BLOOMFIELD, CT 06002

EXAMINER	
SHIPMAN, JEREMIAH E	
ART UNIT	**PAPER NUMBER**
2859	

DATE MAILED: 12/12/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/710,278	WEYERS ET AL.	
	Examiner	Art Unit	
	Jeremiah Shipman	2859	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *28 October 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-17* is/are pending in the application.

4a) Of the above claim(s) *8* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-7 and 9-17* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 14-16 are rejected under 35 U.S.C. 102(b) as being anticipated by Sugimoto (US 4,785,246).

Regarding claim 14, Sugimoto discloses an apparatus for MRI (col 2, lines 25-27) comprising means for generating a gradient field ("inclined magnetic field coil", col 2, lines 42-47), means for generating an RF field (col 2, lines 40-42), and means for RF shielding the gradient field generating means (col 2, lines 47-50), wherein the RF field generating means and the RF shielding means are configured to have a Q-factor equal to or greater than a defined threshold Q-factor, the defined threshold Q-factor being defined as 50% of the Q-factor that the RF shield generating means and the RF shielding means would provide as a result of the RF shielding means being made from a sheet of solid copper having a thickness of about three times the skin depth at a frequency of about 64 MHz (col 2, lines 10-18; Fig 2; Sugimoto describes "a cylindrical high-conductivity member made of copper foil". Copper foil is known in the art to have thicknesses which are widely variable, but which are of order one mil (about 25 microns). The skin depth of copper at 64 MHz is about 8 microns (from Applicant's Eqn 1), and so "about three times the skin depth" is about 25 microns, or 1 mil. Therefore,

the solid copper foil cylinder described by Sugimoto has a Q-factor of about twice the defined threshold Q-factor, which is defined as 50% of the Q-factor of the shield described by Sugimoto, which is a solid copper sheet having a thickness of about three times the skin depth at a frequency of about 64 MHz.)

Regarding claim 15, the RF shielding means described by Sugimoto comprises means for conducting eddy currents induced by the means for generating an RF field (this is inherent to an RF shield since, as is well known in the art, the mechanism by which the RF shield shields RF frequencies is by conducting the eddy currents induced by the RF field; e.g., Sugimoto col 2, lines 15-18).

Regarding claim 16, Sugimoto discloses a means for RF shielding comprising means for blocking eddy currents induced by the means for generating gradient field (col 2, lines 50-54; col 4 lines 1-15, 42-55; Sugimoto describes several mechanisms for introducing region(s) which are electrically discontinuous at the gradient field frequencies, while still being quite good conductors at the much higher RF frequencies. In these embodiments, the eddy currents induced by the gradient fields are blocked by these discontinuities (Sugimoto, col 4, lines 30-34; 42-55). Since in the RF properties of the shield are perturbed very little (col 4, lines 42-55), the Q-factor of the configuration may change slightly from being the Q-factor of a solid copper foil sheet of the appropriate thickness, but will still be considerably higher than the defined threshold Q-factor of 50% of this value since it has only changed slightly.)

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-7 and 9-16 are rejected under 35 U.S.C. 103(a) as being anticipated by Richard et al. (US 5,592,087) in view of Frederick (US 5,367,261), de Swiet et al. (US 2004/0113617), Morich et al. (US 5,406,204), Hayes et al. (US 4,642,569), and Sugimoto (US 4,785,246).

Regarding claim 1, Richard et al. disclose an apparatus for MRI (col 1, lines 7-14), comprising an RF birdcage coil having a coil axis, an end ring portion disposed about that axis, and a plurality of legs disposed parallel to the axis and in signal communication with the end-ring portion (col 2, lines 61-65; Fig 5), and an RF shield disposed about the coil (col 2, lines 62-64) and in signal communication therewith, the shield comprising a cylindrical conductive sheet having first and second ends (col 4, lines 24-28), a plurality of sets of discontinuous slots disposed about the cylindrical sheet and running between the first and second ends (col 4, lines 31-35; Fig 5), wherein a region of discontinuity within a set of the slots aligns with the end ring portion (col 5, lines 57-62; Figure 5).

Regarding claims 14-16, Richard discloses an apparatus for MRI comprising means for generating a gradient field (col 3, lines 52-65), a means for generating an RF field (col 2, lines 61-65; Fig 5), and an RF shielding means (col 2, lines 62-64). The RF

shielding means of Richard comprises means for conducting eddy currents induced by the means for generating an RF (high-frequency) field (col 5, lines 12-21) and means for blocking the eddy currents induced by the means for generating a gradient (low freuquency) field (col 5, lines 22-28).

Regarding claim 4, Richard et al disclose that the number of sets of discontinuous slots is equal to or greater than the number of legs (Fig 5).

Regarding claims 2 and 3, Richard fails to teach that the region of discontinuity has an axial length equal to or greater than the width of the end ring portion. Frederick teaches an RF shield for a birdcage coil (abstract, lines 1-5) with end-ring conductors corresponding to and lined up with the end-rings of the birdcage (col 2, lines 51-53; col 5, lines 49-53). These conductors serve the same physical shielding purpose as the discontinuities in applicant's slots (RF shielding of the end-ring portions of the birdcage coil). Frederick's conductors have a width (determined by maximizing the Q-factor of the coil) equal to or greater than twice the width (and thus greater than the width) of the conductors in the birdcage coil (col 2, lines 49-69; col 6 lines 1-2). It would have been obvious to one of ordinary skill in the art at the time of the invention to apply the teaching of Frederick to the teaching of Richard et al. for determining the geometry of the conductors in the RF shield to maximize the Q-factor of the RF coil (Frederick, col 5, lines 56-59) and minimize the interaction of the resultant RF coil with the gradient coil assemblies (Frederick, col 6, lines 32-37), which is the purpose of the shield.

Regarding claim 5, Richard et al lack an RF shield comprising a material having an electrical conductivity equal to or greater than about 2% and equal to or less than

about 20% the electrical conductivity of pure copper. De Swiet et al. disclose shields disposed about RF coils in an MRI apparatus (paragraphs 5-6), which may be made of a poor conductor (paragraph 29, lines 19-21). It would have been obvious to a person skilled in the art at the time of the invention to apply the teaching of de Sweit to the teaching of Richard in order to better reduce eddy current circulation (de Sweit, paragraph 19, lines 27-29).

Regarding claims 6-7 and 9, Richard lacks a shield which comprises a mesh, a mesh which comprises a copper alloy, and a mesh embedded in epoxy at the gradient coil. Morich et al disclose an RF shield for use in an MRI apparatus (col 1, lines 11-19) which comprises a mesh (col 5, lines 27-30), a mesh comprising a copper alloy (col 5, lines 27-30, copper is a copper alloy), and a mesh embedded in epoxy at the gradient coil (col 5, lines 50-55). It would have been obvious to one of ordinary skill in the art at the time of the invention to apply the teachings of Morich to the teachings of Richard in order to gain the conventional advantages of a mesh shield over a foil shield—cost effectiveness and the mesh's intrinsically lessened conduction of low-frequency eddy currents (i.e., it will interfere less with the gradient pulses) (Morich, col 2, lines 54-56)—as well as the advantage of being easier to embed in epoxy (Morich, col 5, lines 52-55).

Regarding claim 10, the combination of Richard and Morich lacks a region of discontinuity in the slots having an axial length equal to or greater than the width of the end ring portion of the birdcage coil. Frederick teaches this limitation, as discussed above in regard to claims 2 and 3.

Regarding claim 11, Richard et al. fail to teach that the plurality of sets of slots are disposed between the plurality of legs. Hayes et al. teach an RF shield for a magnetic resonance apparatus (col 1, lines 6-10) with slots etched therein, creating conductive strips which are parallel to and centered on the conductors of the RF coil (col 4, lines 61-68; col 5 lines 1-3). This means that the etched slots must be located between the legs of the RF coil. It would have been obvious to a person of ordinary skill in the art at the time of the invention to apply the teaching of Hayes to the teaching of Richard in order to improve the performance of the RF shield as explained by Hayes (col 4, lines 48-58).

Regarding claim 12, Richard's slots are equally spaced (Fig. 5).

Regarding claim 13, Richard et al. fail to teach an RF shield comprising an integrally formed capacitor running lengthwise between the first and second ends, the capacitor being disposed only partially around the circumference of the cylindrical sheet. Sugimoto teaches an RF shield for an MRI apparatus (col 2, lines 26-34) comprising such an integrally formed capacitor (col 4, lines 42-56; Fig 8). It would have been obvious to a person of ordinary skill in the art at the time of the invention to apply the teaching of Sugimoto to the teaching of Richard et al, in order to provide a shield which blocks high frequency RF fields while passing low frequency gradient fields (Sugimoto, col 4, lines 21-24, 51-54).

As to the limitation regarding the relationship to the Q-factor that would hypothetically be attained if the shield were made of a solid copper sheet, the combination of the above references provides substantially the same structure and

operates in substantially the same way as the invention detailed in the applicant's specification, and thus the RF shield described by the above combination of references should provide substantially the same results as does applicant's in terms of quality factor, namely, the shield decribed above is configured to have a Q-factor equal to or greater than a defined threshold Q-factor, the defined threshold Q-factor being defined as 50% of the Q-factor that the RF shield generating means and the RF shielding means would provide as a result of the RF shielding means being made from a sheet of solid copper having a thickness of about three times the skin depth at a frequency of about 64 MHz.. Further, those of ordinary skill in the art would be guided in combining the references by the principle known in the art to optimize (maximize) the Q-factor of the coil-shield configuration since the advantages of higher Q-factor, such as higher SNR, are widely known in the art (Richard, col 5, lines 49-56; Morich, col 2, lines 25-27) and since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the "optimum range" involves only routine skill in the art. *In re Aller*, 105 USPQ 233.

Claim 17 is rejected under 35 U.S.C. 103(a) as being unpatentable over Richard et al. in view of Morich et al., and further in view of Sugimoto. Richard et al. disclose an apparatus for MRI (col 1, lines 7-14), comprising an RF birdcage coil having a coil axis, an end ring portion disposed about that axis, and a plurality of legs disposed parallel to the axis and in signal communication with the end-ring portion (col 2, lines 61-65; Fig 5), and an RF shield disposed about the coil (col 2, lines 62-64) and in signal

communication therewith, the shield comprising a cylindrical conductive sheet having first and second ends (col 4, lines 24-28), a plurality of sets of discontinuous slots disposed about the cylindrical sheet and running between the first and second ends (col 4, lines 31-35; Fig 5), wherein a region of discontinuity within a set of the slots aligns with the end ring portion (col 5, lines 57-62; Figure 5). Richard fails to teach a shield comprising a copper alloy mesh and an integrally formed capacitor disclosed only partially around the circumference of the cylindrical sheet. Morich et al disclose an RF shield for use in an MRI apparatus (col 1, lines 11-19) which comprises a mesh (col 5, lines 27-30), a mesh comprising a copper alloy (col 5, lines 27-30, copper read is copper alloy), and a mesh embedded in epoxy at the gradient coil (col 5, lines 50-55). It would have been obvious to one of ordinary skill in the art at the time of the invention to apply the teachings of Morich to the teachings of Richard in order to gain the conventional advantages of a mesh shield over a foil shield—cost effectiveness and the mesh's intrinsically worse conduction of low-frequency eddy currents (i.e., it will interfere less with the gradient pulses) (Morich, col 2, lines 54-56)—as well as the advantage of being easier to embed in epoxy (Morich, col 5, lines 52-55). The combination of Richard and Morich now only fails to teach an RF shield comprising an integrally formed capacitor running lengthwise between the first and second ends, the capacitor being disposed only partially around the circumference of the cylindrical sheet. Sugimoto teaches an RF shield for an MRI apparatus (col 2, lines 26-34) comprising such an integrally formed capacitor (col 4, lines 42-56; Fig 8). It would have been obvious to a person of ordinary skill in the art at the time of the invention to apply the teaching of

Sugimoto to the teaching of Richard et al, in order to provide a shield which blocks high frequency RF fields while passing low frequency gradient fields (Sugimoto, col 4, lines 21-24, 51-54).

Response to Arguments

Applicant's arguments with respect to claims 1-7 and 9-13 have been considered but are moot in view of the new ground(s) of rejection.

Applicant's arguments with respect to claims 14-16 have been considered but are moot in view of the new ground(s) of rejection.

Regarding claims 13 and 17, Applicant's arguments filed 28 October 2005 have been fully considered but they are not persuasive.

Applicant asserts that "Sugimoto [teaches] insulating members to define a discontinuous portion 46 that does not run lengthwise between first and second ends (see Figure 7), and not an integrally formed capacitor running lengthwise between the first and second ends", that "an integrally formed capacitor arranged as claimed and performing as the claimed invention performs, is substantially different from the insulating member in Sugimoto", and that there is "no discussion in the References relating to such a dielectric arrangement (not just an insulating arrangement)".

Firstly, it should be noted that Sugimoto's Figure 7 and Figure 8 depict different embodiments (col 4, lines 42-44: "Electromagnetic coupling member 43 is not limited to

the structure having slits 46 [Figure 7], and may *alternatively* be constructed so that... [Figure 8]") (Emphasis and bracketed material added), and so the slot which does not run from end to end as shown in Figure 7 is not relevant to the overlapping sheets of copper sandwiching an insulator as described in column 4, lines 42-56 and in Figure 8, referenced in the original rejection.

Secondly, "dielectric" is synonymous with "insulating" in an electrical sense. For example, www.dictionary.com gives as a definition:

> **dielectric**
>
> n : a material such as glass or porcelain with negligible electrical or thermal conductivity [syn: insulator, nonconductor] [ant: conductor]
>
> Source: *WordNet ® 2.0, © 2003 Princeton University*

Lastly, the integrally formed capacitor of Sugimoto necessarily runs from end-to-end, since it is formed by overlapping but *separate* sheets of copper (col 4, lines 44-46). The overlapping regions of these conductors are further described to have interposed between them insulating members 54 (col 4, lines 47-48). As is acknowledged by applicant (Specification; Par 25; Eqn 2), two overlapping conductive regions separated by an insulating region define a capacitor. Further, Sugimoto states that the purpose of this arrangement is the advantage over his other embodiments, such as a simple slit, that "high-frequency waves can be securely prevented from leaking out" (col 4, lines 51-53) while preventing interaction with the gradient coils by preventing the flow of eddy currents (col 4, lines 30-34; 47-48). This is the same purpose and performance as

desired and described by applicant, who states that "the capacitance *C* is sized high such that capacitor 190 has a low impedance *X* at the Larmor frequency" (that is, it appears as a solid conductive (low-impedance) sheet to the high-frequency waves, thus preventing them from "leaking out") (Spec, Par 25, lines 10-11) while at the same time it "couples less to the Z-gradient coil 105 than does an arrangement having an electrical connection and no integrally formed capacitor" (that is, because the flow of the eddy currents induced by the gradient coils is interrupted by the electrically discontinuous region, which has high impedance (appears as an electrically discontinuous region) at this lower frequency) (Spec, Par 27). Thus, the structure of Sugimoto does define an integrally formed capacitor running from end to end, and does perform substantially as the applicant's claimed invention.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jeremiah Shipman whose telephone number is (571)272-8439. The examiner can normally be reached on Monday-Friday, 8:30am-5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Diego Gutierrez can be reached on (571)272-2245. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

JS

Michael J. Tokar

Michael Tokar
Supervisory Patent Examiner
Technology Center 2800